Calgary Cycle Track Network - a new way to launch

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Introduction

In June 2015, a network of cycle tracks were opened to Calgarians. This network of cycle tracks, totaling 5.5 km of physically separated bicycle facilities and 1.0 km of shared street treatments, was a game-changer for the City. With bicycle facilities typically being implemented one route at a time and staged over a number of years, this project changed that paradigm by implementing a base network with four routes in two months.

Due to the fast-paced nature of this project, the planning, design, and implementation was all within a close time frame (two years from network planning to implementation) allowing for a unique comparison of the planning and design intentions with what was implemented and the ultimate performance.

This paper outlines a number of planning and design intentions and compares them to what was implemented. In some cases, the design changed after implementation and based on on-site observations of behaviour or feedback from stakeholders. These special circumstances are also highlighted. Municipalities and practitioners considering implementing separated bikeways will find this paper of high interest and value since best practices will be expanded upon and design nuances will be explained.
Planning

Network planning approach
To create a network of cycle tracks in the downtown core, a series of east-west and north-south corridors were identified. These corridors were typically 3-4 blocks in width and would span the entirety of the study area. The intention was to have each corridor serve a unique catchment of possible users in the study area. For the Centre City area, six north-south and four east-west corridors were identified to be adequate to serve the demand in the Centre City. A key consideration in the identification of the corridors, especially the north-south corridors, was the possibility of these corridors to provide a connection across the significant barriers (e.g. heavy rail tracks) that act as a barrier to movement to many modes of transportation in the area.

Within each corridor, a series of possible cycle track routes were analyzed. These routes utilized a variety of cycle track configurations on the various streets within the corridor to provide connectivity for the corridors duration. The variety of cycle track configurations (ranging between bi-directional, uni-directional, or couplets, when appropriate), were reduced through an evaluation process that considered a variety of different parameters. The parameters used for the Centre City Cycle Track Network were: Connectivity & Ease of Use at Intersections, Demand, Impacts on Other Modes, Conflicts, and Cost and Constructability.
Balancing transportation priorities

Two key considerations within the Multiple Account Evaluation that garnered special attention from stakeholders and the public were automobile parking and travel. As such, these two aspects of planning the network required special analysis.

To address the concerns surrounding automobile movement in the Centre City, a traffic model was created that analyzed all the one-way streets with the removal of a single lane of traffic. The analysis was visually displayed in a map of the study area with the resulting volume-to-capacity ratios colour coded to indicate a degree of congestion. This analysis was used to exclude some streets from the network at an early stage and focus efforts on roadways that could accommodate the changes in the lane arrangements.

With the cycle tracks being planned on-street (as opposed to sidewalk level), the space for the cycle track required the reallocation of either a travel lane or a parking lane. The reallocation of parking in the study area to accommodate cycle tracks resulted in a 366 stall reduction in parking in the study area. To counter the loss of parking in the Centre City, parking was optimized on streets adjacent to the cycle tracks by creating angled parking, adding small vehicle stalls, or converting loading zones to parking areas. As a result, 501 stalls were created in the Centre City, resulting in 135 net new stalls in the study area. An example of the parking analysis used during the cycle track network planning is shown in the figure below.
A changed planning approach
Following the theme of this paper (i.e. changes to the project from initial intentions), the planning of the network was no exception. Initially a network of cycle tracks was proposed from a series of preferred corridors ready for immediate installations. One of the key cycle tracks in this network was 1 Street S.E., the southbound couplet to Macleod Trail, a major roadway in the City. 1 Street S.E. was a viable choice due to it not having as many vehicles using the street and, most importantly, the fact that it was a four-lane street in the area where a cycle track would be installed, but a three-lane street for the remainder of its existence. This would, therefore, lend itself to an easy transition of the cycle track from one river pathway (Bow River) to another (Elbow River) and also serve the main employment heart of the Centre City.
With 1 Street S.E. commonly known to Calgarians as Macleod Trail, the tone of the messaging of the project in the media and public was not positively portrayed, even with strong technical analysis supporting its viability.

As a result of the public discourse that was occurring for this project and, particularly, the uncertainty of some Calgarians to trust the rigour and methodology of the analysis conducted by the City and project team, a pilot network of all the routes was suggested. This would allow for significant data collection to occur while the network of cycle tracks was in place and allow assumptions and hypotheses to be tested. This also allowed for the individual cycle track routes to play a synergistic role in a network of comfortable and accessible bicycle facilities.

After much debate, public discourse, community mobilization (for and against) leading up to and during the public hearing, a network of cycle track routes were approved by Council. These routes were 8 Avenue SW from 11 Street SW to 1 Street SE, 9 Avenue S from 1 Street SE to 4 Street SE, 5 Street SW from 3 Avenue S to 15 Avenue S, and 12 Avenue S from 11 Street SW to 4 Street SE. In total, this was 6.5 kilometres of high quality bicycle facilities in the heart of Calgary’s downtown core.

The map on the left was the proposed cycle track network and the map on the right was the approved cycle track network. 1 Street S.E., the route initially recommended for installation first, was not approved for implementation in the pilot network.
Engagement
The engagement approach and program is not the major focus of this paper, but it should be noted that it is not possible to overemphasize the importance that stakeholder engagement played in this project. Within the 1.5 year planning phase of this project, it is estimated that over 80 separate presentations were made to stakeholders to discuss the project and its various elements. In addition to this, numerous workshops about topics like design treatments or creating bicycle friendly businesses were conducted. Major external stakeholder committee meetings and Steering Committee meetings were held on a monthly basis.

Design
Design Guidance
A number of guidelines were consulted when developing the guidelines for the cycle track installation in Calgary. The following section provides some of the key design aspects of the project.

Design Vehicle
Historically, transportation infrastructure projects focus on providing access to the intended classification of vehicle. The design team completed turning templates for SU-9 trucks and Transit Buses to ensure these vehicles were accommodated in the design. The biggest change in design vehicle came as the type of cyclist we were designing these cycle tracks for; the 8-80 design vehicle. For true success, the cycle tracks had to be designed to ensure both 8 year olds and 80 year olds (and everyone in between) felt comfortable enough to use the network. This was used as a guiding principle throughout the design.

Signage
The cycle track design required the installation of signage within the buffer space. It was not acceptable for City crews to install sign poles into the roadway asphalt or the parking curb barriers. Our team developed a custom design for a tapered nosing, for which sign poles could be fixed. Throughout the project, these were referred to as BTN’s (Bicycle Tapered Nosing). At problem locations where there was an increased potential for the BTN to be hit by a motor vehicle, maintenance crews pinned the BTN’s into the asphalt via 2 pre-drilled holes of 25mm diameter. The 45cm BTN width guided our maximum sign width, which is also 45cm.
The TAC Bikeway Traffic Control Guidelines for Canada (Feb 2012) was used to inform the signage design. Where the design team felt there were gaps in the guidance (primarily due to the fact that the guide does not include cycle track design), several custom designed signs were created as part of this project.

A variation of the TAC RB-37 (Turning Vehicles Yield To Bicycles Sign) was created based on feedback from Calgary Police and other user groups. Our new design maximized the size of the Yield icon and included a supplementary “Yield To Bicycles” tab. The design was manufactured as one 45cm X 90cm sign which included the tab. Variations of this sign were developed, based on the direction of bicycle flow and the whether the vehicle is making a left or right turn across the cycle track.
Several multi-use crossings were installed as part of the project (otherwise referred to as cross-rides or cross-bikes) where off-street cycling infrastructure travelled across roadways. In these cases, a standard TAC WC-7 warning sign with a supplementary ‘Bicycle Crossing’ Tab was used to advise drivers of the crossing.
Furthermore, at all multi-use crossings in the cycle track network pilot, it was decided not to install bicycle signal heads to control the right-of-way. Instead, the ‘bikes use pedestrian signal’ sign was installed for cyclists.

The Alberta Traffic Safety Act Use of Highway and Rules of the Road Regulation states that for the purpose of making a turn, a vehicle must, unless a traffic control device otherwise directed or permits, turn by driving the vehicle as closely as practicable to the curb or edge of the roadway then entered. Where a vehicle could potentially turn into a cycle track (at an intersection, driveway or alley), keep right (or left) of median signage with a supplemental ‘except bicycles’ tab were installed, which is the traffic control device that directs vehicles not to turn into the cycle track.
The introduction of a two-way cycle track on a one-way road required a modification of the regulatory signage which communicated this layout. For the pilot project, the standard one-way regulatory sign was modified to include an ‘except bicycles’ tab. Both signs were manufactured as one at a size of 90cm x 30cm. This is different than the design implemented on the 7th Street SW cycle track, where all one-way signage (since it is technically a two-way road with the introduction of a two-way cycle track) were removed. At the end of the pilot, both designs will be evaluated and a final decision will be made.

The City of Calgary’s Traffic Bylaw states that a person shall not ride a bicycle on or along a sidewalk. However, the Traffic Engineer may designate portions of sidewalk where bicycles may be ridden. Throughout the pilot project (typically at locations where cycle tracks end or begin) a number of sidewalks were designated where bicycles may be ridden. These portions of sidewalks are indicated by using the following sign (45cm x 90cm), which also acts as a reminder for cyclists not to interfere with pedestrians:
Detour signage was temporarily installed on-street during the construction period to bring awareness to citizens of the coming changes. Visuals of the coming changes provided key information and helped citizens understand what to expect. These signs were well received and will be a continued practice on all new bicycle projects city-wide.

Road marking
The TAC Bikeway Traffic Control Guidelines for Canada (Feb 2012) was used to inform the road marking design. Where the design team felt there were gaps in the guidance (primarily due to the fact that the guide does not include cycle track design), other industry best practices were used (NACTO, CROW, FHWA, etc).

City of Calgary practice for bike lanes is to use a 200mm outside line width to separate between adjacent lanes. This practice was applied to our cycle track buffer design for the outside line. The inside buffer line width used was 100mm. The minimum buffer
The width used was 0.9m, measured from the center of the 200mm outside line and the center of 100mm inside line.

A solid 100mm yellow centre line was applied inside two-way cycle tracks. The dashed yellow centre line was considered; however, when considering the use of centerlines in the urban setting, use of the solid centerline is nearly used exclusively. While the solid yellow line still allows all operations to occur legally (Alberta laws), the appearance of the solid yellow may discourage overtaking of a slower going cyclist.

Standard bicycle and diamond stencils were applied at the beginning and ending of every block. At site specific locations where higher pedestrian movements across the cycle track were found, additional bicycle stencils were applied. An example location where bicycle stencils were applied is on 8th Ave where an adjacent hotel loads and unloads guests.

Four levels of conflict zone markings were developed based on traffic engineering first principles. Curve warning signage serves as a good metaphor for this practice; as the level of risk of an approaching curve on a roadway is increased there are more and more tools a traffic engineer can use to emphasis the nature of the curve. A graduated level of treatment can be referred to, from simple curve warning signage all the way to supplementary flashing lights and overhead warning messages. Similarly, where there is an increased risk of conflict across a particular intersection, driveway or alley, varying conflict zone treatments can be used. Where turning volumes are low, low level guidelines are used. Where moderate turning volumes are present, medium level treatment is used with guidelines and bicycle stencils. Where higher numbers of turning vehicles are present, the highest level of markings with guidelines, bicycle stencils and green paint are applied. The exact numbers to differentiate low, medium and high level are still in development. At intersections and alleyways with permissive vehicle movements across the cycle track, high level conflict zone markings are automatically applied. The City of Calgary version of the RB-37 sign is installed at all high level conflict zones. At intersections where there are greater than 100 turning vehicles in any of the peak hours, the design team separated the bicycles and provided a protected phase. Where there were protected phases, high level conflict markings were typically not applied.

Details of the conflict zone treatments can be found below. A fourth possible treatment, not shown, is to not have any markings provided. The length of dashed marking in the conflict zones is always 1.5m x 1.5m. Several conflict zones were initially installed with lower level treatment, which were changed to high level treatment after site observations and public feedback. Using 1.5m x 1.5m dashed lines made it very easy for crews to upgrade the treatment; simply having to fill in the gaps with green paint and apply bicycle stencils.
TAC Bikeway Design Guidance was used to determine the road marking treatment within multi-use crossings. “Elephants feet” road markings were applied at all these locations to help formalize the multi-use crossing.
Concrete Construction
Council had directed staff that this was to be a pilot project, as such temporary materials were to be used. Since concrete construction was to be avoided, this introduced a major constraint to the project. However, the design team was able to make modifications to existing concrete under very special circumstances.

One design change that the City of Calgary implemented with concrete construction was the bicycle ramp detail. All new bicycle ramps were constructed such that they met the asphalt surface without a lip, providing a much nicer transition to/from roadways.

Signal Construction
The pilot project had to minimize the amount of permanent construction that was completed, which was the case for signals construction as well. On all the new two-way cycle tracks, bicycle signal heads had to be installed in the new direction. The design team took advantage of temporary signal bases (referred to as Norman Wells at the City of Calgary) for which most of the new signals were installed. The design team also took advantage of existing signal poles which could be used to add the additional bicycle signal heads. On the 8 Avenue cycle track which has two-way traffic, no new
bicycle signal heads were required. Cyclists use the existing traffic lights, along with the motor vehicle traffic.

**Signal Timing**
Detailed capacity analysis was completed for every intersection within the pilot project. Signal timings helped reduce delay for motor vehicles, while balancing the progression for cyclists as well. Where intersection turning volumes across the cycle track were greater than 100 vehicles in either of the peak periods, protected cyclist phases were implemented to manage the conflict.

**Barriers**
The cycle track project was initially planned for the phased application of corridors over four years. The corridors were meant to be built similar to the 7 Street cycle track that was undertaken by the City just one year prior. The separation buffer would be cast-in-place concrete, done in conjunction with the planned mill and overlay of the roadway.

Upon council’s decision to implement the complete cycle track network in a pilot, the plan was changed to construct and operate 5.5 km, 43 intersections 34 bike signals within a two month construction window during late winter and early spring. The weather was not expected to cooperate in the wettest month of the season. With the tight construction schedule it was no longer feasible or desirable to use cast in place concrete medians as the separation buffer. The choice of cycle track material was carefully considered for the project in order to accommodate the desired completion date of the cycle track network.
A number of separation treatments were evaluated based on the following criteria.

- Safety Benefit
- Height of Barrier
- Relative Cost
- Durability and ease of replacement
- Perceived comfort
- Ease of procurement/construction
- Winter maintenance
- Aesthetics

The delineators proved to be the best solution for many reasons. They have the look and feel of a temporary/pilot treatment, which was one of the requirements and they provide a physical separation contributing to a greater sense of safety for cyclists. For cycle tracks adjacent to parking, the precast concrete curb was the most cost effective and versatile choice. Most importantly, this satisfied the requirement that parking must be adjacent to a curb, as stated in the Alberta Traffic Safety Act. The delineator spacing we used for the cycle track pilot project was 5.0m.
The minimum buffer width without adjacent parking (and without presence of parking curbs) is 0.3m, measured from center of 200mm outside buffer line and center of 100mm inside buffer line.

The Alberta TSA Rules of the Road states that a vehicle must park adjacent to a curb within a set distance. Therefore, where parking was permitted adjacent to the cycle track, the design team installed parking curbs to resolve this provincial requirement. The parking curbs were placed within the buffer space, just inside of the 200mm outside
line. Delineators were then installed on top of the parking curbs. During construction, some of the parking curbs were being damaged from the installation of the delineators. Construction crews were given direction to install the delineators using two bolts instead of the four available and that resolved the issue.

The minimum buffer width used when parking is present is 0.9m, measured from the center of the 200mm outside line and the center of 100mm inside line. Thus far, we have not received any complaints about door-zone issues. The 0.9m buffer guidance was taken from NACTO.

**Legal**

With decades of history dedicating our roadway to servicing automobile, it’s no surprise that the laws have not considered the accommodation of bicycle on the roadway. Especially with the idea of vehicular cycling, lawmakers are free to ignore special accommodation for bicycle when we expect them to behave like a vehicle.

In Calgary, The Alberta Traffic Safety Act, Use of Highway and Rules of the Road Regulation covers the appropriate use of the roadway for all users. It considers bicycle as a “vehicle” and therefore subjects it to the same regulations as it would an automobile. The designs of cycling facilities, especially cycle tracks, are more nuanced than simply copying other jurisdictions. The following table highlights the design intention, issues faced, and ultimate resolution surrounding the legal issues faced when implementing the cycle track network.
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<thead>
<tr>
<th>Desire</th>
<th>Issue</th>
<th>Resolution</th>
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</thead>
<tbody>
<tr>
<td><strong>Shared space on Stephen Avenue</strong></td>
<td>Stephen Avenue bylaw restricting the use of bicycles on Stephen Avenue</td>
<td>City’s Legal department had bylaws rewritten, passed through council, and enacted prior to cycle track opening</td>
</tr>
<tr>
<td><strong>Multi-Use Crossing (e.g. Cross Bike, Cross Ride)</strong></td>
<td>Void in Traffic Safety Act and bylaw surrounding regulations for people riding bicycles to travel in crosswalks</td>
<td>New bylaw created enabling design for multi-use crossing. Does not preclude cyclists from exercising caution when entering roadway.</td>
</tr>
<tr>
<td><strong>Parking as buffer</strong></td>
<td>Requirement for parking to be within 0.5 metres of curb and typical painted buffers not being considered as a curb.</td>
<td>To adhere to the Traffic Safety Act, precast concrete parking curbs were placed in the separation buffer to define parking limits.</td>
</tr>
</tbody>
</table>

**Elements of Success**

- Early identification of legal hurdles and engaging the City’s law department. Council expediting the process of these enabling amendments.
- Support for bylaw from Council and Senior Administration.
- No issues since opening.
- Simple construction.
It was noted during the design that due to the nuanced nature of legislation, simply implementing precedent designs from other jurisdictions was not possible. A deliberate and focused effort towards addressing design and legislative issues is required.

### Parking
Parking is a very important issue amongst businesses and the public. The following table highlights the design intention, issues faced, and ultimate resolution surrounding parking for the cycle track network.

<table>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>On 8 Avenue:</strong> Provide 3.4 m vehicle lane, 1.0 buffer, and 2.0 m cycle track width by eliminating parking</td>
<td>Public expressed desire to reinstate on-street parking</td>
<td>Lane widths below minimum standards were provided to reinstate a parking lane.</td>
</tr>
<tr>
<td><strong>Minimize the loss of parking</strong></td>
<td>Parking was desired throughout the project study area</td>
<td>Provide off-peak parking lanes</td>
</tr>
<tr>
<td>Travel demand varies during the day which may allow for off-peak parking</td>
<td></td>
<td>Elements of Success</td>
</tr>
<tr>
<td><strong>Increase downtown parking</strong></td>
<td>Parking was desired throughout the project study area</td>
<td>Micro Stalls</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Off-cycle track parking locations provided through angled parking</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Elements of Success</td>
</tr>
<tr>
<td></td>
<td>Ensure design flexibility</td>
<td>Do not limit scope of work to a single street</td>
</tr>
</tbody>
</table>
Retrofitting a cycle track into the built environment is not an easy task. People who drive have come to expect the roadway to operate in a certain way, the on-street parking, the free flow traffic, the turn restrictions, etc. Addition of the cycle track changes the way people use the street. One of the main concerns heard in engagement sessions was the loss of on-street parking along the cycle track routes. It was important to balance the need for roadway capacity during peak hours and desire for on-street parking at other times of the day. Since travel demand varies during the day, opportunities for the travel lanes to be used as on-street parking were pursued.

**Transitions**
Maintaining a cyclist’s level of comfort from one facility to another is important to consider when designing a network of bicycle facilities. The following table highlights the design intention, issues faced, and ultimate resolution surrounding transitions for the cycle track network.

<table>
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<td>Transitioning from two-way cycle track to two one-way facilities</td>
<td>Low compliance from cyclist (possibly due to inattention or defiance) The risk of injury is high when travel mode crosses.</td>
<td>Immediate remedy to alert cyclist to bike signals and crossing instructions. Further non-compliance resulted in closure of route until a new design was completed. New design is less intuitive, but safer for the users.</td>
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</table>

**Elements of Success**
- Immediate remedial action
- Remote monitoring and record of incorrect usage.
- Anticipate unintended usage and potential impact of misuse.
**Bus Stops**

One of the considerations for cycle track corridor selection was to position the two-way cycle track on the left side of one way streets. This was strategically chosen to avoid potential complication of interfacing bus stops with the cycle track. Where one way cycle tracks were implemented on 8 Avenue and 9 Avenue, special design treatments for the interface of the bus stop and the cycle track were determined.

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| **Shared Lane – 8 avenue** | Bus loading and unloading of customers needing to use the fold down ramp.  
Median bus stop is not wide enough to accommodate bus offloading ramp. | This is an infrequent bus route so a shared lane was appropriate in this context.                                                                                                                             |
| **Floating transit stop** |                                                                                                                                              | **Elements of Success**                                                                                                                                                                                     |
|                          |                                                                                                                                              | Transit service provider agreeable to have bus rerouted, therefore minimizing the frequency of the risk.                                                                                                   |
|                          |                                                                                                                                              | Communicate to bus drivers to be aware of cyclist on the street.                                                                                                                                             |

Accommodation for large volume of queuing customers requires special attention in managing the potential conflict between users. In some circumstances, the pedestrian realm was reconstructed to create a space wide enough to accommodate the queuing transit users and a shared space behind the bus shelter for bicycle to use.
Conclusions
This paper outlines a number of planning and design intentions and compares them to what was implemented. In some cases, the design changed after implementation and was based on on-site observations of behaviour or feedback from stakeholders.

By piloting an entire network of cycle tracks, a variety of cycle track alignments were designed, all with nuanced design aspects. By piloting the network of cycle tracks, flexibility in design changes allowed for significant learning opportunities to be experienced. If permanent construction had been completed, design changes would still have been possible, but significant cost and delays would have been incurred.